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Appeal Brief

(A) Identification

Applicant name: W. Richard Purcell, Jr.

Application number: 10/034,872

Application filing date: 12-28-2001

Title of invention: Method and apparatus for informing investors for judging, selecting, and maintaining investment portfolio plans that offer optimal prospects for their long-term financial plans, goals, and priorities.

Examiner name: Clement B. Graham

Examiner art unit: 3696

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(B) Table of Contents

(C) Real Party in Interest	3
(D) Related Appeals and Interferences	4
(E) Status of Claims	5
(F) Status of Amendments	6
(G) Summary of Claimed Subject Matter	7
(H) Grounds of Rejection to be Reviewed on Appeal	8
(I) Argument	9
(J) Claims Appendix	10
(K) Evidence Appendix	11
(L) Related Proceedings Appendix	12

(C) Real Party in Interest

The real party in interest is PlanScan, LLC, a Colorado limited liability company, the assignee of record.

(D) Related Appeals and Interferences

None.

(E) Status of Claims

Claims withdrawn from consideration previously: 8, 10, 31, 33, 43.

Claims rejected: 1-7, 9, 11-30, 32, 34-42, 44-74.

Claims on appeal: 1-7, 9, 11-30, 32, 34-42, 44-74.

Appellant appeals rejection of the independent claims 1 and 71. Appellant also appeals rejection of all other claims on appeal, namely claims 2-7, 9, 11-30, 32, 34-42, 44-70, and 72-74, appealing that these claims be accepted based on acceptance of the independent claims 1 and 71 on which they are dependent.

(F) Status of Amendments

None.

(G) Summary of Claimed Subject Matter

It's my understanding that as a layperson appellant without legal counsel, I am not required to fulfill the specifications for sections G and H of the Brief. But I do want to provide a summary of some aspects of the claimed invention and rejections especially relevant to my Argument. The following is intended as a layperson's summary of selected aspects of the claimed invention.

The purpose of my invention is to apply estimates of investments' return-rate probabilities, defined by estimated return-rate averages and standard deviations, to inform people for selecting investment portfolios offering optimal result probabilities for their retirement and other long-term financial plans, goals, and priorities. For this purpose, the following considerations are essential:

1. Time horizon of investment uncertainties and probabilities extends through periods of investment withdrawal for meeting goals

Some investments are made for one financial goal at one particular future time, with no investment uncertainties or probabilities thereafter. For example, the investment goal might be a sum for future purchase of a house, or future purchase of a bond or annuity with known returns thereafter involving no further uncertainty. For such single-investment-goal plans, goal-meeting probabilities may be calculated relatively simply by equation.

But for most individual investors, the primary investment goal is income for many retirement years, typically twenty or more, and for growth potential the investment will be held through retirement years with withdrawals each year to meet that year's retirement income goal, and a goal for final wealth thereafter. For these investment plans investment uncertainties continue through the years of withdrawals for meeting the goals, and to determine probabilities of meeting the goals the probability analysis must extend through those withdrawal years to the final wealth thereafter. For these investment plans, various amounts are held through different numbers of years, and analysis of the probabilities for the results and meeting of the goals is far more complex.

My invention is designed to produce probability analyses for the latter kind of investment plan. Accordingly, the time horizon covered by its probability analyses extends through periods of withdrawal from the investment to meet goals, to a final wealth thereafter. This is stated in my independent claim 1: its first step, obtaining, defines the time horizon as including periods of withdrawal to meet goals and defines final wealth as wealth thereafter (*page 16 of this Brief*), and its third step, determining, states that its probability analysis covers this time horizon and final wealth (*see page 16*). My other independent claim, claim 71 regarding apparatus, states the same definitions of time horizon and final wealth thereafter and the same probability analysis coverage.

2. For investments with return-rate probabilities, return rates vary from period to period

For investments with return-rate probabilities, actual return rates vary from period to period. The very meaning of their standard deviations, used to define their probabilities, is a technical measure of their variation. For investment plans that include periods of withdrawals to meet

goals, period-to-period return-rate variation affects investments' future-result prospects in the following three ways:

The variations lower multi-period results – This effect can be called “variation drag.” For a given average return rate over multiple periods, return-rate variation lowers the multi-period results. Or stated the other way, if the variations are not taken into consideration, the calculated result will be higher than the actual result.

This result-lowering effect of return-rate variations can be illustrated with a two-year example. If a \$1.00 investment's return rate is 20% in period 1 and 0% in period 2, its average return rate will be 10% and the two-year result will be \$1.20. But if the two-year return is calculated without the variations, using the average rate of 10% each year, the calculated result will be too high: \$1.21. For typical long-term investments of many years, if the period-to-period variations are not considered, the calculated results can be far too high.

For amounts invested for less than the total time horizon, withdrawn before the end for meeting goals, the uncertainties of the average return rates are greater – This effect is shown by a rule called “reversion toward the mean, and can also be illustrated with a familiar example.

The more times we flip a coin, the more likely it is that all the results will average closer to 50% heads and 50% tails – and correspondingly, the fewer flips, the further from 50-50 the total result is likely to be. Exactly the same for investments' average return rates. The sooner an amount is withdrawn to meet a goal, reducing the number of periods invested, the wider the range of uncertainty for that amount's average return rate.

For many investors, period-to-period return-rate variation is itself an important criterion for investment selection – For many investors, large ups and downs in investment value are so unnerving that instead of simply selecting an investment with best probabilities for the long-term goals, the investor's priorities are best met by trading off some long-term probabilities in order to reduce prospects for how large the short-term variations are likely to be.

To incorporate and reflect these complications and effects of period-to-period return-rate probabilities, my invention applies a method used for situations too complex for easy calculation in science and engineering: simulation. In simulation, many examples of what the result could be are produced, each produced according to the relevant factor probabilities, and from all the examples probabilities for the result are produced.

In my invention, to incorporate period-to-period return-rate probabilities and their effects, each simulation example proceeds period by period with a return rate determined for each period according to the investment's return-rate probabilities. This probability analysis is stated in my independent method claim, claim 1, in its third step, developing (*see page 16 in this Brief*), and is similarly stated in my other independent claim on apparatus, claim 71 (*see page 26*).

3. For investors' plans and goals, different investments offer different tradeoffs among three investment-selection criteria, and different investors have widely differing priorities regarding tradeoffs among the three criteria

When investment portfolios ranging from more conservative (such as mostly bonds) to more aggressive (such as mostly stocks) are assessed and compared for an investor's plan and goals,

one of these portfolios will have highest probability of meeting that investor's goals. But moving from that portfolio toward more aggressive portfolios, goal-meeting probabilities will be only slightly lower while possibilities for much higher results will be greater. To an aggressive investor, a more aggressive portfolio may fit the investor's priorities better.

On the other side, moving from the portfolio with highest goals-meeting probabilities toward more conservative portfolios, there may be only small reductions in goals-meeting probabilities but much better probabilities that if there is a shortfall it will be smaller, and better prospects that the period-to-period value variations along the way will be smaller. To a more conservative investor one of these more conservative portfolios may fit the investor's priorities better.

Individual investors vary greatly in their priorities regarding these tradeoffs – some very aggressive, some very conservative, most with priorities through a range in between. In other words, what portfolios are optimal for particular investors depends not only on the plans and goals, but also on the investor's priorities in tradeoffs among the three criteria.

The importance of considering all three criteria is illustrated by training of fiduciary investment advisors, who are obligated to try to serve investors' best interests. One could argue that according to cold logic, the focus should be only on probabilities for results for the long-term goals. But concern with period-to-period variations is so high for many investors that fiduciary investment advisors are trained to try to give major consideration to the investor's "risk tolerance," which is code for the investor's attitude toward period-to-period variations. Variations much larger than the investor expects can scare the investor into abandoning the investment.

To best enable each investor to choose a portfolio that fits his/her plan, goals, *and priorities*, it's necessary to assess investments from conservative to aggressive as to what each portfolio offers for the investor's particular plan and goals in all three criteria:

- (a) Probability of meeting the goals
- (b) Probabilities for how much higher or lower results may be
- (c) Prospects for period-to-period variations along the way

It is also essential to provide comparisons of the portfolios, first in probabilities for meeting the investor's goals, so the investor can see which portfolio offers highest probabilities for meeting his/her goals, and also see other more aggressive and more conservative with probabilities nearly as good, for the investor to compare in criteria (b) and (c).

My invention is designed to perform these portfolio assessments in all three criteria and the comparisons as stated just above. In my independent claim 1, step 3 on developing describes its analyses of the portfolios on all three criteria (*see page 16 in this Brief*), and claim 1's step 4 on preparing states its preparation of a first comparison of the portfolios in criterion (a) as a basis for the investor's selection of portfolios to compare in criteria (b) and (c) (*see page 17*).

(H) Grounds of Rejection to be Reviewed on Appeal

All claims on appeal, including my independent claims 1 and 71, are rejected under 35 U.S.C. 103(a) as being unpatentable over Edesess U.S. Patent 5,884,287 in view of Wallman U.S. Patent 6,360,210.

The rejection of claim 1 has the following elements:

1. As basis for the rejection, Edesess is said to obtain information for and perform probability analysis through a time horizon including not only the periods of addition to investment but also the periods of withdrawals from the investment to meet the goals, and a final wealth thereafter.

To support this representation of Edesess, the rejection cites essentially the entire Edesess text: entire Abstract, entire Summary of the Invention excluding only the last three sentences, and entire Detailed Description.

(For this element of rejection and citation, see page 28 in this Brief; for the cited Edesess text, see pages 34-40.)

2. As basis for the rejection, Edesess is said to develop probability distributions for the final wealth at the end of the time horizon through period-by-period simulation, in which a return rate is determined for each period, to assess the investments in all three criteria including prospects for period-by-period path of value variation through the time horizon.

To support this representation of Edesess, the rejection cites essentially the entire Edesess text: entire Abstract, entire Summary of the Invention excluding only the last three sentences, and entire Detailed Description.

(For this element of rejection and citation, see page 29 in this Brief; for the cited Edesess text, see pages 34-40.)

3. As basis for the rejection, it is said that, while Edesess does not provide comparison of the investment portfolios in probabilities for the investor's plan and goals, to inform the investor for selecting portfolios for comparison in all three criteria, in view of a cited excerpt from Wallman, it would have been obvious to apply the teachings of Edesess to provide such comparison, providing the investor a basis for considering how the portfolios compare in all three criteria to judge a portfolio optimal for his/her plan, goals, and priorities.

To support this representation of Edesess in view of Wallman, the rejection cites Wallman column 6 lines 1-65 and column 9 lines 19-65.

(For this element of rejection and citation, see pages 29-30 in this Brief; for the cited Wallman text, see pages 42-43.)

Rejection of my other independent claim, claim 71 regarding apparatus, is based on the same representations and citations regarding Edesess and the same representation and citation regarding Wallman. *(See pages 31-33 in this Brief.)*

(I) Argument

Edesess certainly has words that make it appear similar to my invention.

But Edesess meets none of the three requirements met by my invention as summarized in this brief's section (G) Summary of Claimed Subject Matter. The bases for rejection of my independent claims 1 and 71, statements that these requirements are met by Edesess or Edesess in view of Wallman, are not correct. The rejection citations from Edesess and Wallman show that the rejection statements regarding Edesess and Wallman are not correct.

This is not to deny utility of either Edesess or Wallman, but to state that Edesess utility is limited to much simpler investment situations than my invention, and for complementing Edesess in meeting these requirements of my invention, the rejection's Wallman citation is of no use.

1. Edesess probability analysis excludes periods of use of investment proceeds to meet goals

Contrary to the rejection statement that Edesess assesses probabilities through a time horizon including the periods of uses of investment proceeds to meet goals, and a final wealth thereafter, the Edesess citation provided in the rejection shows that Edesess probability assessment *excludes* periods of use of investment proceeds, covering only a time horizon before such periods and a "final wealth" before such periods.

(One might hypothesize that Edesess analysis could be extended to cover such periods, but as will be shown in #2 below, the Edesess method of probability assessment is wholly deficient for such assessments.)

Citation 1 -- The Edesess exclusion from its probability assessments of periods of use of investment proceeds is shown by numerous statements in the rejection's Edesess citation. Here is one:

Column 6, lines 39-40 – The horizon date for each scenario is generally the investor's retirement age

By "horizon date" Edesess refers to the endpoint of its probability analysis. This statement means that for most investors for whom my invention is designed and suited, people investing for income in each of many retirement years and intending to keep invested through those years for investment growth, Edesess probability analysis is fatally deficient because it fails to consider investment uncertainties and probabilities through the retirement years of investment withdrawals to meet each year's retirement goal.

Citations 2 and 3 -- In another place in the Edesess text cited in the rejection, and in a figure cited in that Edesess text, the following statements are made:

Column 4 lines 46-50 -- Step 102. This target scenario is in the form of (1) net amounts invested annually between the present date and a future horizon date T1 and (2) a wealth goal at time T1 representing investor's liability for future expenditures after T1.

Fig. 3A, step 102 -- Specify target scenario in the form of: (1) net amounts invested annually between present date and a future horizon date T1; and (2) a wealth goal at time T1 representing investor's liability for future expenditures after T1.

In these statements, T1 represents the end of the time horizon for which Edesess performs its probability analysis. The "wealth goal" represents an amount calculated for goal expenditures in periods thereafter, which are not included in the Edesess probability analysis.

Citation 4 -- In another place in the Edesess text cited in the rejection, description of the equation that is at the very heart of the Edesess probability assessment includes the following:

Column 5, lines 34-35 -- C_i is the net addition (contribution) to assets at the beginning of the i 'th year

This means that the Edesess probability assessment is focused on the periods when the investor is adding or contributing to the investment, typically the pre-retirement years – not covering the years of withdrawals from the investment to meet the goals.

Citations 5 and 6 -- In two other places in the rejection citation, Edesess states how periods of use of investment proceeds are to be calculated:

Column 5, lines 8-11 -- These future levels of wealth accumulation may be derived as present values of future spending levels planned to occur subsequent to the horizon dates.

Column 6, lines 44-48 -- The wealth goals are calculated as the present value liabilities, as of the horizon dates, for the future planned withdrawals from the investment account for retirement income, bequest, and any other post-horizon expenditures.

These statements mean that periods of spending or withdrawals occur after the time horizon for which Edesess performs its probability analysis, and are instead to be analyzed by present value.

Summarizing, these specific citations show that the rejection statement that Edesess probability analysis covers the periods of investment withdrawals to meet goals is not correct.

This is not to deny that Edesess has utility. For investment plans in which the proceeds are to be used all at once such as for purchase of a house, or in which the proceeds are not to be kept invested through withdrawal periods, the time horizon and "final wealth" for which Edesess performs its probability analysis is fine.

But for investment plans and goals for which my invention is designed, including the plans and goals of most individual investors in which investment is held through years of withdrawals for retirement, the Edesess probability assessment does not assess probabilities of meeting goals. It produces only a probability distribution for an interim wealth, rather than a final wealth, which does not show probabilities of meeting the goals and is useless for that purpose because it fails to consider and reflect the uncertainties and probabilities of the investment performance through the withdrawal years.

One might hypothesize that Edesess be changed to make its probability assessments include the periods of withdrawals from the investment to meet the goals. But for such assessments the Edesess method is fatally deficient, as described in #2 immediately below.

2. The Edesess method fails to incorporate period-to-period return-rate variations. For plans that include periods of investment withdrawals to meet goals, the Edesess method would produce incorrect results for two of the three investment-selection criteria assessed by my invention and no answer at all for the third.

As evidence for the rejection statement that Edesess probability analysis is period-by-period simulation, in which a return rate is determined for each investment period, the rejection again cites essentially the entire Edesess text: the entire Abstract, entire Summary of the Invention except for last three sentences, and the entire Detailed Description.

However, within that citation the rejection statement is not supported, but shown to be incorrect. Within that entire citation, there is no mention of determining return rates for individual periods, nor of simulation. The rejection citation shows that instead, Edesess probability analysis is based on an equation, and central to that equation is an assumption that the return rate will be the same in every period through the time horizon, with no period-to-period variations.

This assumption of same return rate every period is shown most explicitly in the equation at the very heart of the Edesess method, presented in the text cited in the rejection and also in three Edesess claims:

*Column 5 following line 26,
and claims 2, 7, and 11 --*

$$f(r) = V_0(1+r)^n + \sum_{i=0}^{n-1} C_i(1+r)^{n-i} - V_n$$

In this Edesess equation, the letter **r** represents a constant return rate for all the periods, with no period-to-period variation.

For every investor planning withdrawals for meeting goals in multiple periods, such as for income in retirement years – that is, for most investors for whom my invention is designed – the Edesess failure to incorporate period-to-period return-rate variations makes Edesess unable to validly assess and compare investments on any of the three investment-selection criteria.

Without consideration of those period-to-period variations, Edesess cannot inform investors of investments' prospects for period-to-period variations in either return rates or resulting investment values.

And for the other two criteria, probability of meeting the goals and probabilities for how much higher or lower the results may be, the Edesess failure to consider period-to-period return-rate variations makes its assessments incorrect in two ways: probable results too high, uncertainties of those results too small, as described in the next two paragraphs.

Probable results too high -- For a given average return rate, variations above and below the average lower the multi-period result. This can be illustrated by considering a \$1 investment that over two years has return rates of 20% and 0%, ending the two years at \$1.20. If instead one omits the year-to-year variations, assuming that the investment has its average return rate each year, 10%, the two-year result is higher, \$1.21. Thus calculations that omit the year-to-year variations produce too-high multi-year results. For longer time horizons of many years, the error can be very great.

Result uncertainties too low – After using the Edesess equation to determine the minimum return rate required to meet an investor’s goals Edesess determines an investment’s probability of having that high an average rate over the time horizon. But for every plan with goal withdrawals in multiple periods, some of the investment will be held for less time, and according to the rule of reversion toward the mean, for investments held for fewer periods the uncertainties for the return-rate average are wider. By failing to reflect these wider uncertainties, the Edesess method understates the uncertainty of results for the total plan.

In summary, for every plan that includes goals to be met by investment withdrawals in multiple periods, the Edesess method is way too over-simplified. So even if Edesess were changed to cover the full investment time horizon including periods of withdrawals to meet goals, its method would fail to produce any of the three investment-selection criteria my invention produces. For criteria (a) probability of meeting the goals and (b) probabilities for how far above or below the goals results may be, Edesess answers would be doubly wrong, showing probable results too high with too little uncertainty. And for criterion (c), prospects for period-to-period value variations along the way, Edesess would produce no result at all.

3. Edesess method fails to reflect period-to-period return-rate variations

After my invention assesses the investment portfolios on all three criteria, as stated in claim 1’s step 3, developing, in step 4, providing, it provides a comparison of the investment portfolios as a basis for judging, selecting, and maintaining an investment optimal for his/her plan, goals, and priorities. The rejection states that while Edesess provides no such comparison, in view of the rejection’s citation from Wallman, it would have been obvious to modify the teachings of Edesess to provide such comparisons

However, Edesess in view of the Wallman citation does not provide grounds for the stated rejection, for the following reasons:

Wallman is irrelevant -- The Wallman citation is irrelevant and useless for the stated purpose. The Wallman citation does not provide or even mention any portfolio comparison, or even address portfolio selection. Instead, as described in its Abstract, Wallman’s purpose and method are for specifying and pricing insurance for a portfolio previously selected.

(See the Wallman Abstract on page 41 of this Brief, and the Wallman excerpt cited in the rejection on the following two pages.)

Edesess time horizon and method are inadequate – For what my invention does, the teachings of Edesess are inadequate and incorrect. As summarized in preceding pages, Edesess probability assessment fails to include probabilities for periods an investment is held for withdrawals for meeting the goals, and even if Edesess were changed to include probabilities of these periods, its method would produce incorrect answers for two of my invention’s investment selection criteria and for the third criterion provide no answer at all.

Edesess purpose is different -- Edesess is not even designed for the same purpose as my invention – in fact, just the opposite. My invention is designed to inform the investor of how, for his/her plan and goals, investments compare differently on the three selection criteria, so the investor is informed to see the tradeoffs and judge an investment portfolio that best fits his/her plan, goals, *and priorities*. Edesess is instead based on the notion that its inventor knows what every investor’s investment-selection should be, and is designed so that after

gathering numbers from the investor, Edesess makes the investor's portfolio choice according to fixed selection rules.

The fixed investment selection rules that Edesess applies in its making of investment selections for all investors are described in the Edesess Summary of the Invention as follows:

Column 2 lines 65-67 – column 3 lines 1-7 – The unique investment allocation to the major asset classes is found that meets the following criteria: first, if any allocation achieves the required fallback rate of return with at least the required probability, then among those allocations that satisfy this criterion the unique one with the maximum probability of achieving the target rate of return is found; second, if no allocation achieves the required probability of the fallback rate of return, then the allocation is selected that maximized this probability, though less than the required probability.

While these fixed selection rules may fit the priorities of some investors, with investor varying greatly in their aggressive or conservative priorities, most might make choices different from those made for them by Edesess if informed on how the investments compare in all three criteria by my invention. For example, fiduciary investment advisors trained in the importance of trying to take into account each investor's "risk tolerance" would be troubled to learn that for the many investors for whom period-to-period variations are of concern, Edesess would make investment selections without any consideration of these concerns.

CONCLUDING ARGUMENT

Except for locations in referenced texts, everything stated in this Argument section and throughout this Brief applies fully and equally to my two independent claims, claim 1 on method and claim 71 on apparatus. In each the same four steps are stated, for each the rejection is based on the statements and citations summarized in the Grounds of Rejection section, and for each the grounds for rejection are shown to be invalid by this Arguments section.

These arguments show that compared to my invention, Edesess in view of Wallman is fundamentally different in scope, method, purpose, and utility.

Therefore I request that these two claims be allowed, that based on these allowances all the other claims which are dependent on these two claims be allowed, and that my invention be determined to merit patent.

Respectfully submitted

W. Richard Purcell, Jr.

(J) Claims Appendix

1. A method that relates to informing investors for judging, selecting, and maintaining informed commitment to investment portfolios with optimal prospects for their long-term investment plans, goals, and priorities, comprising:

obtaining information on a financial plan including a time horizon of a plural number of investment periods from the time of an initial investment through times of withdrawals for meeting goals, amounts to be invested in a plurality of the periods, at least a first withdrawal amount to be withdrawn for a goal in a period before the end of the time horizon, and an amount of a final wealth goal at the end of the time horizon; and information on a plurality of investment categories including expected return rates, return-rate standard deviations, and correlation coefficients for the individual investment period;

identifying a series of investment portfolio plans from more conservative to more aggressive, comprising portfolios each with a different expected return rate and a return-rate standard deviation for the individual period, each portfolio comprising a mix of investment categories diversified to offer its expected return rate with smallest or nearly smallest return-rate standard deviation;

developing for each portfolio plan, through simulation, a probability distribution for the final wealth for the financial plan with that portfolio plan, each simulation proceeding period by period through the time horizon, each period adding any amounts to be invested in that period, subtracting any amounts to be withdrawn in that period, and applying for each portfolio a return rate determined for that period based on the portfolio's expected return rate and return-rate standard deviation, the simulations and probability distributions providing a basis for comparing the portfolio plans in various aspects of prospects for the financial plan and goals including probability that the final wealth result will be at least as great as the final wealth goal, probabilities for how far above the goal the final wealth result may be, probabilities for how far below the goal the final wealth result may be, and prospects for period-by-period path of value variation and development through the time horizon; and

providing at least a first comparison of the portfolio plans in a first criterion, that criterion being probability that the final wealth will meet or exceed the goal, revealing which of the portfolio plans are best and close to best with respect to the first criterion, to inform the investor for selecting portfolio plans for comparison in other aspects of prospects for the plan and goals, selection of a portfolio plan the investor judges optimal for his plan, goals, and priorities, and the investor's informed commitment to the choice.

2. A method, as claimed in claim 1, wherein:

 said investment period is the year.

3. A method, as claimed in claim 1, wherein:

 at least one of said investment categories is an asset class.

4. A method, as claimed in claim 1, wherein:

 at least one of said investment categories is a mutual fund or other investment vehicle.

5. A method, as claimed in claim 1, wherein:

 said identifying step includes displaying identifications of a number of investment categories from which the user may choose said a plurality of investment categories.

6. A method, as claimed in claim 5, wherein:

 said displaying step includes displaying data on return rates of said investment categories.

7. A method, as claimed in claim 6, wherein:

 said displaying step includes enabling revision or replacement by the user of at least one of said identifications or said data on return rates.

9. A method, as claimed in claim 1, wherein:

 said financial plan includes a plurality of investment amounts or portions of investment amounts subject to different rules of taxation.

11. A method, as claimed in claim 1, wherein:

said financial plan includes data to enable calculation of amounts and time periods of deductions from a portfolio plan for fees and costs and for taxes including deductions based on investment returns, withdrawals from a portfolio, and portfolio value.

12. A method, as claimed in claim 1, wherein:

 said financial plan includes at least a first inflation rate to enable calculation of inflation adjustments of future values.

13. A method, as claimed in claim 1, wherein:

 said financial plan includes information defining as a probability distribution said number of said investment periods in said time horizon, said first inflation rate, or any other item of said information on said financial plan.

14. A method, as claimed in claim 1, wherein:

 any investment amount, withdrawal amount, final wealth, or other measure of financial value may be expressed either before or after adjustment for any of the following: any fees and costs, any taxes, any inflation.

15. A method, as claimed in claim 1, wherein:

 said identifying step includes applying concepts of Modern Portfolio Theory using **said** data on return rates of a plurality of investment categories to obtain information defining an efficient frontier curve on a graph, said curve comprising a range of portfolio points **each** representing a number of portfolios offering various expected return rates with smallest return-rate standard deviations.

16. A method, as claimed in claim 15, wherein:

 said applying step includes applying concepts and methods known collectively as CAPM including investing or borrowing at a rate commonly termed a "risk-free" rate.

17. A method, as claimed in claim 1, wherein:

 said portfolios includes only portfolios having allocation proportions that conform to at least a first allocation constraint defining a minimum or maximum total allocation proportion for each of a number of said investment categories.

18. A method, as claimed in claim 1, wherein:

said portfolios includes only portfolios in which the allocation proportions of said investment categories are integer multiples of an integer allocation percentage increment.

19. A method, as claimed in claim 18, wherein:

said portfolios are grouped and characterized with respect to expected return rate according to an incremental sequence of expected return rates.

20. A method, as claimed in claim 15, wherein:

said applying step includes displaying said efficient frontier curve on an efficient frontier graph with axes representing expected return rate and return rate standard deviation.

21. A method, as claimed in claim 20, wherein:

said displaying step includes showing on said efficient frontier graph a number of portfolio points each representing a user-specified portfolio.

22. A method, as claimed in claim 20, wherein:

said displaying step includes enabling user interaction with said graph including choosing at least a first portfolio point and showing information for said first portfolio point graphically and numerically, said information including an expected return rate, a return rate standard deviation, and allocation proportions of at least a first portfolio corresponding to said first portfolio point.

23. A method, as claimed in claim 22, wherein:

said information includes allocation proportions for each of a plurality of portfolios determined to best correspond to said first chosen portfolio point.

24. A method, as claimed in claim 22, wherein:

said information includes upper and lower limits at a specified confidence level for the highest and lowest return rate in the best and worst investment periods of said time horizon.

25. A method, as claimed in claim 1, wherein:

each of said portfolio plans comprises a plurality of component portfolio plans in which separate investment amounts or separate portions of investment amounts may be placed.

26. A method, as claimed in claim 25, wherein:

said component portfolio plans in a portfolio plan are subject to different rules of taxation.

27. A method, as claimed in claim 25, wherein:

said component portfolio plans in a portfolio plan comprise different portfolios.

28. A method, as claimed in claim 1, wherein:

at least one portfolio plan or component portfolio plan is rebalanced at the end of at least a first investment period, having at the start of the next investment period the same portfolio as at the start of said first investment period.

29. A method, as claimed in claim 1, wherein:

at least one portfolio plan or component portfolio plan is reallocated at least once during said time horizon, comprising one portfolio before said reallocation and another portfolio after said reallocation.

30. A method, as claimed in claim 1, wherein:

said series comprises portfolio plans that each have the same number of component portfolio plans and are all defined according to a common system of increments and limits regarding portfolios in the first investment period of said time horizon and times and methods of rebalancing and reallocation of portfolios in subsequent investment periods of said time horizon.

32. A method, as claimed in claim 1, wherein:

said first criterion is the highest value that said final wealth has a predetermined probability of ..
equaling or exceeding.

34. A method, as claimed in claim 1, wherein:

said simulation includes determining separately for each investment period of each simulation a return rate for at least a first portfolio of said portfolio plan for said investment period by random selection from a probability distribution for the return rate of said portfolio.

35. A method, as claimed in claim 34, wherein:

said probability distribution for a return rate is determined using an expected return rate and a return-rate standard deviation and assuming one of a number of shapes for said probability distribution.

36. A method, as claimed in claim 35, wherein:

said assuming step includes assuming that said shape of said probability distribution is normal or lognormal.

37. A method, as claimed in claim 34, wherein:

said determining step includes establishing said probability distribution for the return rate of at least one portfolio in at least one investment period using at least a first serial correlation coefficient reflecting an effect upon said probability distribution of at least one return rate in at least one previous investment period.

38. A method, as claimed in claim 34, wherein:

said determining step includes ascertaining for at least one investment period a return rate for at least a second portfolio in said portfolio plan in said investment period by random selection from a probability distribution for said return rate determined using a return rate randomly selected for said first portfolio for said investment period and the covariance of the return rates of said first portfolio and said second portfolio.

39. A method, as claimed in claim 1, wherein:

said simulation includes for each simulation determining a return rate for each portfolio in a portfolio plan in each investment period of said time horizon by random selection of a historical investment period using actual historical return rates of investment categories for the selected historical investment period.

40. A method, as claimed in claim 1, wherein:

said simulation includes for each simulation using historical return rates of investment categories for a series of consecutive historical investment periods equal in number to the number of investment periods in said time horizon.

41. A method, as claimed in claim 1, wherein:

said simulation includes determining values of a number of items in said financial plan by random selection from probability distributions of values of said items.

42. A method, as claimed in claim 1, wherein:

said developing step includes grouping final wealths produced by said simulations according to a scale of value increments to develop a final wealth frequency distribution, interpreting said final

wealth frequency distribution as a final wealth probability distribution, and using said probability distribution to determine specifications of said probability distribution such as the expected final wealth or the median final wealth, the probability that the final wealth will equal or exceed a value, or the largest value that the final wealth has a probability of equaling or exceeding.

44. A method, as claimed in claim 1, wherein:

 said providing step includes comparing in said first comparison a number of portfolio plans designated by the user.

45. A method, as claimed in claim 1, wherein:

 said providing step includes displaying for each of said series of portfolio plans a plurality of the following: identifying name, symbol, or number; expected final wealth; median final wealth; probability that the final wealth will equal or exceed a predetermined amount; highest amount that the final wealth has a predetermined probability of equaling or exceeding; an expected return rate characteristic of the portfolio plan; a return-rate standard deviation characteristic of the portfolio plan; a lowest-return-rate characteristic of the portfolio plan for an individual investment period relative to a predetermined probability; and a lowest-return-rate characteristic of the portfolio plan for the investment period in which said characteristic is lowest of all investment periods in said time horizon relative to a predetermined probability.

46. A method, as claimed in claim 1, wherein:

 said providing step includes presenting said first comparison graphically.

47. A method, as claimed in claim 46, wherein:

 said presenting step includes displaying said first comparison in a graph with a first axis representing said first criterion, a second axis representing a second measure of said portfolio plan, and a portfolio plan point representing each portfolio plan in said series relative to said first axis and said second axis.

48. A method, as claimed in claim 47, wherein:

said second measure is one of the following: identifying name, symbol, or number; expected final wealth; median final wealth; probability that the final wealth will equal or exceed a predetermined amount; highest amount that the final wealth has a predetermined probability of equaling or exceeding; an expected return rate characteristic of the portfolio plan; a return-rate standard deviation characteristic of the portfolio plan; a lowest-return-rate characteristic of the portfolio plan for an individual investment period relative to a predetermined probability; and a lowest-return-rate characteristic of the portfolio plan for the investment period in which said characteristic is lowest of all investment periods in said time horizon relative to a predetermined probability.

49. A method, as claimed in claim 47, wherein:

 said displaying step includes choosing by the user of at least a first portfolio plan point represented on said graph.

50. A method, as claimed in claim 49, wherein:

 said choosing step includes choosing by the user of a value along an axis of said graph from which value said first portfolio plan point is designated.

51. A method, as claimed in claim 49, wherein:

 said choosing step includes displaying values associated with said first portfolio plan point relative to each axis of said graph.

52. A method, as claimed in claim 49, wherein:

 said choosing step includes identifying at least a first portfolio plan designated to correspond to said first portfolio plan point.

53. A method, as claimed in claim 52, wherein:

 said identifying step includes displaying allocation proportions of at least a first portfolio of said first portfolio plan.

54. A method, as claimed in claim 53, wherein:

 said displaying step includes presenting additional information necessary to determine all allocation proportions of all portfolios in said first portfolio plan in each investment period of said time horizon.

55. A method, as claimed in claim 49, wherein:

 said choosing step includes identifying each of a plurality of portfolio plans designated to correspond to said first portfolio plan point.

56. A method, as claimed in claim 49, wherein:

 said choosing step includes selecting at least a first portfolio plan corresponding to a point on said graph.

57. A method, as claimed in claim 56, wherein:

 said selecting step includes displaying a probability distribution graph showing a probability distribution of the final wealth of said first portfolio plan.

58. A method, as claimed in claim 57, wherein:

 said displaying step includes showing on said probability distribution graph a probability distribution of the final wealth of a second portfolio plan.

59. A method, as claimed in claim 57, wherein:

 said displaying step includes indicating by the user of a target value for the final wealth of a portfolio plan.

60. A method, as claimed in claim 59, wherein:

 said indicating step includes showing for each of a number of portfolio plans represented on said probability distribution graph the probability that the final result will equal or exceed said target value.

61. A method, as claimed in claim 56, wherein:

 said selecting step includes displaying a simulations graph showing at least a first simulation of the progression of portfolio value investment period by investment period through the time horizon for said first portfolio plan.

62. A method, as claimed in claim 61, wherein:

 said displaying step includes showing on said simulations graph a plurality of said simulations.

63. A method, as claimed in claim 61, wherein:

 said displaying step includes showing on said simulations graph a number of said simulations for a second portfolio plan.

64. A method, as claimed in claim 56, wherein:

· said selecting step includes displaying a sensitivity graph in which a first axis represents a range of values for a first item of said financial plan, a second axis represents a range of values for said first criterion, and values are represented for said first criterion of said first portfolio plan for each of a plurality of values of said first item of said financial plan.

65. A method, as claimed in claim 64, wherein:

· said first item of said financial plan is said time horizon.

66. A method, as claimed in claim 64, wherein:

· said displaying step includes showing on said sensitivity graph values for said first criterion of a second portfolio plan for each of a plurality of values of said first item of said financial plan.

67. A method, as claimed in claim 64, wherein:

· said displaying step includes showing on said sensitivity graph a plurality of curves each representing a different value for a second item of said financial plan and showing values of said first criterion of said first portfolio plan for each of a plurality of values of said first item of said financial plan.

68. A method, as claimed in claim 64, wherein:

· said displaying step includes choosing by the user of a value for each of a number of items of said financial plan and displaying a corresponding value of said first criterion for said first portfolio plan.

69. A method, as claimed in claim 1, wherein:

· said obtaining step includes providing a user interface on a screen of a computer or other electronic device for user selectable display of said information including entry boxes in which the user may make entries or changes in said information and buttons or other interaction objects by which the user may make selections pertaining to said information, said investment categories, said portfolios, and said portfolio plans.

70. A method, as claimed in claim 1, wherein:

· said providing step includes providing a user interface on a screen of a computer or other electronic device for user selectable display of a number of said comparisons, graphs, and

information on portfolio plans, including scrollbars, buttons, or other objects through which the user may make selections and carry out other interactions relative to said comparisons, graphs, and information.

71. An apparatus that relates to finding best investment portfolio plans for long-term financial plans and goals, comprising:

computer memory for storing information on a financial plan including a time horizon of a plural number of investment periods from the time of an initial investment through times of withdrawals for meeting goals, amounts to be invested in a plurality of the periods, at least a first withdrawal amount to be withdrawn for a goal in a period before the end of the time horizon, and an amount of a final wealth goal at the end of the time horizon; and information on a plurality of investment categories including expected return rates, return-rate standard deviations, and correlation coefficients for the individual investment period; and

at least a first computer processor for:

identifying a series of investment portfolio plans from more conservative to more aggressive, comprising portfolios each with a different expected return rate and a return-rate standard deviation for the individual period, each portfolio comprising a mix of investment categories diversified to offer its expected return rate with smallest or nearly smallest return-rate standard deviation;

developing for each portfolio plan, through simulation, a probability distribution for the final wealth for the financial plan with that portfolio plan, each simulation proceeding period by period through the time horizon, each period adding any amounts to be invested in that period, subtracting any amounts to be withdrawn in that period, and applying for each portfolio a return rate determined for that period based on the portfolio's expected return rate and return-rate standard deviation, the simulations and probability distributions providing a basis for comparing the portfolio plans in various aspects of prospects for the financial plan and goals including probability that the final wealth result will be at least as great as the final wealth goal, probabilities for how far above the goal the final wealth result may be, probabilities for how far below the goal the final wealth result may be, and

prospects for period-by-period path of value variation and development through the time horizon; and

providing at least a first comparison of the portfolio plans in a first criterion, that criterion being probability that the final wealth will meet or exceed the goal, revealing which of the portfolio plans are best and close to best with respect to the first criterion, to inform the investor for selecting portfolio plans for comparison in other aspects of prospects for the plan and goals, selection of a portfolio plan the investor judges optimal for his plan, goals, and priorities, and the investor's informed commitment to the choice.

72. An apparatus, as claimed in claim 71, further comprising:

an electronic display screen for displaying at least said first comparison including display of said first comparison in a graph.

73. An apparatus, as claimed in claim 71, further comprising:

input devices for the user to enter, select, change, and otherwise determine said information and information on portfolio plans and to interact with said comparisons including selection of said information and comparisons to be displayed on an electronic display screen.

74. An apparatus, as claimed in claim 71, further comprising:

communication devices for obtaining electronically said information from other computers and for sending said information and comparisons to other computers.

(K) Evidence Appendix

This appendix contains the texts of the rejections of the independent claims 1 and 71 and the Edesess and Wallman texts cited as grounds for these rejections.

Text of rejection of claim 1

As per claim 1, Edesess discloses a method that relates to informing investors for judging, selecting, and maintaining informed commitment to investment portfolios with optimal prospects for their long term investment plans, goals and priorities, comprising:

obtaining information on a financial plan including a time horizon of a plural number of investment periods from the time of an initial investment through times of withdrawals for meetings goals, amounts to be invested in a plurality of the periods, at least a first withdrawal amount to be withdrawn for a goal in a period before the end of the time horizon, and an amount of a final wealth goal at the end of the time horizon (see abstract and column 2 lines 31-67 and column 3 lines 1-29 and column 4 lines 4-67 and column 5-7 lines 1-67) and information on a plurality of investment categories including expected return rates, return-rate standard deviations, and correlation coefficients for the individual investment period identifying a series of investment portfolio plans from more conservative to more aggressive, comprising portfolios each with a different expected return rate and a return-rate standard deviation for the individual period, each portfolio comprising a mix of investment categories diversified to offer its expected return rate with smallest or nearly smallest return-rate standard deviation (see abstract

and column 2 lines 31-67 and column 3 lines 1-29 and column 4 lines 4-67 and column 5-7 lines 1-67)

developing for each portfolio plan, through simulation, a probability distribution for the final wealth for the financial plan with that portfolio plan, each simulation proceeding period by period through the time horizon, each period adding any amounts to be invested in that period, subtracting any amounts to be withdrawn in that period, and applying for each portfolio a return rate determined for that period based on the portfolio's expected return rate and return-rate standard deviation, the simulations and probability distributions providing a basis for comparing the portfolio plans in various aspects of prospects for the financial plan and goals including probability that the final wealth result will be at least as great as the final wealth goal, probabilities for how far above the goal the final wealth result may be, probabilities for how far below the goal the final wealth result may be, and prospects for period-by-period path of value variation and development through the time horizon(see abstract and column 2 lines 31-67 and column 3 lines 1-29 and column 4 lines 4-67 and column 5-7 lines 1-67).

Edesess fail to explicitly teach providing at least a first comparison of the portfolio plans in a first criterion, that criterion being probability that the final wealth will meet or exceed the goal, revealing which of the portfolio plans are best and close to best with respect to the first criterion, to inform the investor for selecting portfolio plans for comparison in other aspects of prospects for the plan and goals, selection of a portfolio plan the investor judges optimal for his plan, goals and priorities, and the investor's informed commitment to the choice.

However Wallman discloses according to the present invention, a computer-based system for managing risk underlying a portfolio of assets/liabilities, includes a graphical user interface, a memory (with a custodial feature), a processor and a link to the party incurring the risk, which could include the public markets through publicly traded hedging devices such as puts and calls. The graphical user interface enables the user to enter information about the portfolio, including a list of assets/liabilities, values for each of the assets/liabilities, shares owned or a percentage of each issue as part of the entire portfolio, and an input of what the user wishes to have limited for downside risk

("shielded or protected"). The memory with the custodial feature stores the portfolio to be shielded. The processor analyzes the portfolio using, among other known techniques, value-at-risk and sensitivity algorithms and probabilistic analysis to determine an expected likelihood of a catastrophic loss in value at a plurality of specified levels and a likely distribution of outcomes for the portfolio over specified periods, and can also calculate the cost of hedging the risk through the purchase of instruments traded in the public markets. Furthermore, the processor provides a series of choices to the user via the graphical user interface to select a time period or periods for which the user seeks shielding from market risk for the portfolio, (ii) a degree of market risk protection, said processor pricing the requested shielding including by reviewing the cost of hedging, and (iii) a menu of pricing mechanisms. The linkage to the third party incurring the risk can be an internal linkage if the system operator will be incurring the risk directly, or to an independent third party such as an insurance company, a hedge fund, or another party that is incurring the risk (including the public markets if the risk is hedged through publicly traded instruments), etc.(see column 6 lines 1-65 and column 9 lines 19-65).

Therefore it would have been obvious tone of ordinary skill in the art at the time the invention was made to modify the teachings of Edesess to include providing at least a first comparison of the portfolio plans in a first criterion, that criterion being probability that the final wealth will meet or exceed the goal, revealing which of the portfolio plans are best and close to best with respect to the first criterion, to inform the investor for selecting portfolio plans for comparison in other aspects of prospects for the plan and goals, selection of a portfolio plan the investor judges optimal for his plan, goals and priorities, and the investor's informed commitment to the choice taught by in order to Wallman in order to allow investors to understand the potential for long term returns from investments in risky assets.

Text of rejection of claim 71

As per claims 71-74, Edesess discloses an apparatus that relates to finding best investment portfolio plans for long-term financial plans and goals comprising: computer memory for storing information on a financial plan including a time horizon of a plural number of investment periods from the time of an initial investment through times of withdrawals for meeting goals, amounts to be invested in a plurality of the periods, at least a first withdrawal amount to be withdrawn for a goal in a period before the end of the time horizon, and an amount of a final wealth goal at the end of the time horizon; and information on a plurality of investment categories including expected return rates, return-rate standard deviations, and correlation coefficients for the individual investment period(see abstract and column 2 lines 31-67 and column 3 lines 1-29 and column 4 lines 4-67 and column 5-7 lines 1-67)

and at least a first computer processor for:

identifying a series of investment portfolio plans from more conservative to more aggressive, comprising portfolios each with a different expected return rate and a return-rate standard deviation for the individual period, each portfolio comprising a mix of investment categories diversified to offer its expected return rate with smallest or nearly smallest return-rate standard deviation(see abstract and column 2 lines 31-67 and column 3 lines 1-29 and column 4 lines 4-67 and column 5-7 lines 1-67)

developing for each portfolio plan, through simulation, a probability distribution for the final wealth for the financial plan with that portfolio plan, each simulation proceeding period by period through the time horizon, each period adding any amounts to be invested in that period, subtracting any amounts to be withdrawn in that period, and applying for each portfolio a return rate determined for that period based on the portfolio's expected return rate and return-rate standard deviation, the simulations and probability distributions providing a basis for comparing the portfolio plans in various

aspects of prospects for the financial plan and goals including probability that the final wealth result will be at least as great as the final wealth goal probabilities for how far above the goal the final wealth result may be, probabilities for how far below the goal the final wealth result may be and prospects for period-by-period path of value variation and development through the time horizon (see abstract and column 2 lines 31-67 and column 3 lines 1-29 and column 4 lines 4-67 and column 5-7 lines 1-67).

Edesess fail to explicitly teach providing at least a first comparison of the portfolio plans in a first criterion, that criterion being probability that the final wealth will meet or exceed the goal, revealing which of the portfolio plans are best and close to best with respect to the first criterion, to inform the investor for selecting portfolio plans for comparison in other aspects of prospects for the plan and goals, selection of a portfolio plan the investor judges optimal for his plan, goals and priorities, and the investor's informed commitment to the choice.

However Wallman discloses according to the present invention, a computer-based system for managing risk underlying a portfolio of assets/liabilities, includes a graphical user interface, a memory (with a custodial feature), a processor and a link to the party incurring the risk, which could include the public markets through publicly traded hedging devices such as puts and calls. The graphical user interface enables the user to enter information about the portfolio, including a list of assets/liabilities, values for each of the assets/liabilities, shares owned or a percentage of each issue as part of the entire portfolio, and an input of what the user wishes to have limited for downside risk ("shielded or protected"). The memory with the custodial feature stores the portfolio to be shielded. The processor analyzes the portfolio using, among other known techniques, value-at-risk and sensitivity algorithms and probabilistic analysis to determine an expected likelihood of a catastrophic loss in value at a plurality of specified levels and a likely distribution of outcomes for the portfolio over specified periods, and can also calculate the cost of hedging the risk through the purchase of instruments traded in the public markets. Furthermore, the processor provides a series of choices to the user via the graphical user interface to select: a time period or periods for which the user seeks shielding from market risk for the portfolio, (ii) a degree of

market risk protection, said processor pricing the requested shielding including by reviewing the cost of hedging, and (iii) a menu of pricing mechanisms. The linkage to the third party incurring the risk can be an internal linkage if the system operator will be incurring the risk directly, or to an independent third party such as an insurance company, a hedge fund, or another party that is incurring the risk (including the public markets if the risk is hedged through publicly traded instruments), etc.(see column 6 lines 1-65 and column 9 lines 19-65).

Therefore it would have been obvious tone of ordinary skill in the art at the time the invention was made to modify the teachings of Edesess to include providing at least a first comparison of the portfolio plans in a first criterion, that criterion being probability that the final wealth will meet or exceed the goal, revealing which of the portfolio plans are best and close to best with respect to the first criterion, to inform the investor for selecting portfolio plans for comparison in other aspects of prospects for the plan and goals, selection of a portfolio plan the investor judges optimal for his plan, goals and priorities, and the investor's informed commitment to the choice taught by in order to Wallman in order to allow investors to understand the potential for long term returns from investments in risky assets.

[57]

ABSTRACT

The present invention is a computer-implemented system and method to create an optimal investment plan given wealth goals stated in probabilistic form, and to display the resulting probability distributions of wealth accumulations at future times where the method provides inputs for entering and storing in a computer target and fallback scenarios and required probabilities, computes rate of return values responsive to the user input, generates an efficient portfolio array, computes probabilities for the efficient portfolio array related to the rate of return values, iteratively compares the array probabilities so that the target and fallback scenario probabilities are satisfied and an optimum efficient portfolio is selected and then provides a graphical representation of the selected efficient portfolio.

SUMMARY OF THE INVENTION

31 The present invention is a computer-implemented system and method to create an optimal investment plan given wealth goals stated in probabilistic form, and to display the resulting probability distributions of wealth accumulations at future times. Creation of the investment plan includes 33 simultaneous optimization of two allocations, the allocation between current spending and current investment (equivalently, between current spending and future spending) and the allocation of investments to the major asset classes.

35 Wealth goals are stated in the form of a target scenario and fallback scenario. The target scenario, comprising the desired result, encompasses a plan of net savings, accumulating in a specified target wealth goal at a specified future date. The fallback scenario encompasses a more modest plan than the target, including possibly higher net saving, lower future wealth, and/or later date of accumulating the future wealth. The fallback scenario quantifies the worst-case acceptable result given a low, though not zero, probability of 39 occurring, thus serving to place an upper bound on the level of risk that can be taken in pursuit of the target.

41 Required probabilities of achieving the target and fallback scenarios are set by the investor. The required probability of achieving the fallback is necessarily higher than the required 43 probability of achieving the target, and is set at a high level to ensure reasonable certainty of no worse than the fallback result. Required rates of return on investment are then calculated for the target and fallback scenarios. In the calculation of required rates, wealth accumulation is reduced 45 by taxes, expenses, fees and inflation. A probabilistic model of multi-asset investment returns commonly used in the industry is then applied, mathematically called a diffusion process with means equal to a constant vector times time period t and variances determined by a constant covariance 49 matrix times time period t. The unique investment allocation to the major asset classes is found that meets the following criteria: first, if any allocation achieves the required fallback

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rate of return with at least the required probability, then among those allocations that satisfy this criterion the unique one with the maximum probability of achieving the required target rate of return is found; second, if no allocation achieves the required probability of the fallback rate of return, then the allocation is selected that maximized this probability, though less than the required probability. Where the investment portfolio is divided between taxable and tax-deferred accounts, investment asset allocations are optimized simultaneously for the two account categories. 10

If the required probabilities of achieving the target and fallback scenarios cannot be satisfied, the scenarios themselves are altered in an iterative process until the investor arrives at a set of realistic goals that can be achieved by the optimal asset allocation with the required probabilities. 15

Once this set of wealth goals has been arrived at, probability distributions of wealth accumulation at future times are constructed and displayed in formats showing probabilities of various outcomes. It is assumed that the probability distributions of the logarithms of wealth at specified future times are normal, with the target plan of net saving occurring when the investment return is equal to the required rate of return for the target scenario, and the fallback plan of net saving occurring at the 95th percentile of the probability distribution. Thus, the calculations of probability distributions of wealth accumulation incorporate the fact that the saving/spending allocation at any time is dependent on the results of investment to that time. 20 25

4 DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The invention is now described with reference to the accompanying figures.

The present invention is a system and method for characterizing and optimizing an investment plan, including the asset allocation decision and the determination of future goals and net contribution schedules. The system uses a personal computer 10 as shown in FIG. 1. The computer 10 comprises a display having a screen 20 and further includes a number of standard components housed within a casing 25 including disk drives, memory, central processor, peripheral card, etc. Math co-processors or other similar accelerators may also be utilized to enhance computation ability. Additionally, input devices such as a keyboard 30 and mouse input device 40 are used. Alternatively, input devices such as touch screens, digitizing pads, and trackball devices may be used. The computer is designed to operate in a window-based operating system to enhance ease of usability and for the display of graphical data.

Referring to FIG. 2, there is shown generally a block diagram of a system and method 100 which includes the processes and computer-based interactive display techniques for characterizing and optimizing an investment plan, including the asset allocation decision and the determination of future goals and net contribution schedules. The system first provides for input of a user for selected target and fallback investment inflows and outflows and their corresponding probabilities. Step 50. A required rate of return to achieve the target and fallback scenarios is calculated along with an array of efficient portfolios. Step 60. The probabilities for achieving the required rates of return as previously determined are then calculated for each efficient portfolio and compared with the required target and fallback probabilities. Step 70. Once a match is made the results are provided to the user in an interactive display environment. Step 80.

and compared with the required target and fallback probabilities. Step 70. Once a match is made the results are provided to the user in an interactive display environment. Step 80.

Referring to FIG. 3, there is shown in more detail a block diagram of a system and method 100 which includes the processes and computer-based interactive display techniques for characterizing and optimizing an investment plan, including the asset allocation decision and the determination of future goals and net contribution schedules.

- 65 As a preliminary step, an investor formulates a tentative set of goals stated in the form of a target scenario. Step 102. This target scenario is in the form of (1) set amounts invested annually between the present date and a future horizon date T_1 ; and (2) a wealth goal at time T_1 representing the investor's liability for future expenditures after T_1 . Basically, the investor is formulating a desired set of cash flows from a present date to the future horizon date. The collection of amounts invested can be accumulated from a number of sources including savings, retirement plans, inheritances, gifts and securities investments.
- 70 Next, the investor provides a minimum probability of achieving the target scenario, typically 50-60%. The required probability of achieving the target scenario is then specified. Step 104. In the preferred embodiment, the minimum probability of the target scenario is set to a default of 50%.
- 75 Next, the investor formulates a fallback scenario, together with required minimal probabilities of realizing this scenario. Steps 106, 108. The required probability of achieving the fallback is necessarily higher than the required probability of achieving the target, and is set at a high level to ensure reasonable certainty of no worse than the fallback result. In the preferred embodiment, the minimal probability of the

5 fallback scenario is set to a default of 9%. The fallback scenario differs from the target scenario in at least one of the following categories: (1) higher net annual investments; (2) lower future wealth goal; and/or (3) later horizon date. In the general case, "the investor" is any person or entity capable of setting investment goals as probabilities of achieving specified future levels of wealth accumulation at specified future horizon dates. These future levels of wealth accumulation may be derived as present values of future spending levels planned to occur subsequent to the horizon dates. In the latter case the future wealth accumulation goals may be seen to represent liabilities for subsequent outlay requirements. Future cash flows and wealth are assumed to be in real, i.e., inflation-adjusted, terms.

The input of the target and fallback securities and corresponding probabilities is accomplished by virtue of a standard input screen on the computer. By a series of windows or text based prompts, the investor provides numerical inputs to satisfy the required target and fallback information. Input can be performed manually by keyboard or via the mouse device which can be used to scroll through varying options provided to the investor.

For each of the two scenarios, a minimum required rate of return to achieve the goal is calculated. Step 110. The standard rate of return r is the solution to the equation $I(r)=0$ where $I(r)$ is given by the equation:

$$I(r) = V_{t+1} + rV_t - \sum_{i=1}^{t-1} C_i(1+r)^{t-i} V_0$$

where

V_0 is the asset value at the start of an n -year period
 C_i is the net addition (contribution) to assets at the beginning of the i th year
 V_t is the required asset value at the end of the n -year period

In the calculation of the required rates, a reduction for taxes, expenses, fees and inflation is taken. This rate of return is derived from the scenario's scheduled net cash inflows and future wealth accumulation goal. Using the standard Newton-Raphson method is an iterative method for generating a sequence of approximations to a solution of a given equation. In theory, this sequence of approximations should converge to the root of an equation. The Newton-Raphson formula is given by:

$$x_t = x_{t-1} - \frac{f(x_{t-1})}{f'(x_{t-1})}.$$

This results in the required real rate of return after all taxes, expenses, fees and inflation.

Employing the standard mean-variance optimization procedure, an array of efficient portfolios is obtained. Step 112. Each member of the array of efficient portfolios contains separate combinations and apportionments of the asset classes depending on the each respective structure of the portfolio. Where the investor holds both taxable and tax-deferred accounts, each of these portfolios is then reweighted in an optimal manner between taxable and tax-deferred account categories, given the investor's tax rates and assumptions of income yields and turnover rates for the asset categories.

The probabilities of achieving the required rates of return over the horizon period are then calculated for each efficient portfolio and compared with the required target and fallback probabilities. Steps 116-120. Among these portfolios for

which the required fallback probability is achieved, if any, that portfolio is selected which maximized the probability of achieving the target. If, for this portfolio, both target and fallback probability requirements are satisfied, Steps 118-120, then this portfolio is the sought-for optimal qualified portfolio to achieve the investor's goals. Step 122, if no efficient portfolio achieves the required fallback probability, that efficient portfolio is selected which maximizes the fallback probability, though less than the required fallback probability. Step 114.

In the determination of a qualified or desired portfolio, a probabilistic model of multi-asset investment returns commonly used in the industry is applied. This model is mathematically called a *diffusion* process with means equal to a constant vector times time period t and variances determined by a constant covariance matrix times time period t . The unique investment allocation to the major asset classes is found that meets the following criteria: first, if any allocation achieves the required fallback rate of return with at least the required probability, then among those allocations that satisfy this criterion the unique one with the maximum probability of achieving the required target rate of return is selected; second, if no allocation achieves the required probability of the fallback rate of return, then the allocation is selected that maximized this probability, though less than the required probability. Where the investment portfolio is divided between taxable and tax-deferred accounts, investment asset allocations are optimized simultaneously for the two account categories.

It is anticipated that in the typical case, no portfolio will be found initially to satisfy the probability requirements of achieving the goals. In such a case the goals will be revised iteratively until an optimal portfolio can be found to meet the required probabilities.

Referring to FIG. 4, there is shown an interactive computer-based graphical embodiment of the interactive process of goal revision and portfolio optimization. In this embodiment, the investor is an individual formulating an investment plan to provide for children's education, retirement income, a bequest, and other major future expenditures. The horizon date for each scenario is generally the investor's retirement age, which may be different for the two scenarios. The optimum allocation for the initial formulation of the scenarios is initially displayed on the screen, together with the probabilities (i.e. likelihoods) of achieving the goals with this optimal investment allocation. The wealth goals are calculated as the present-value liabilities, as of the horizon dates, for the future planned withdrawals from the investment account for retirement income, bequest, and any other post-horizon expenditures.

In the event that the probabilities of achieving the goals do not satisfy the target and fallback probability requirements, the computer system operator may alter the scenarios by moving the on-screen bars via the keyboard or preferably with a mouse or other similar tracking device. Each time a scenario's cash inflow and outflow plan is altered by a bar movement the computer system automatically recomputes the mix and recalculates the probabilities of achieving the target and fallback goals. The worst-case (99th percentile) short-term percentage decline in assets is also displayed for each asset allocation, and may be manipulated by mouse

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operator is enabled to alter the cash inflows and outflows and the goals of each scenario until acceptable and realistic target and fallback goals are arrived at, with the required probabilities of achievement.

FIGS. 5 and 6 show two different formats used to display the probabilities of the spectrum of possible wealth accumulations at future times. FIG. 5 is the "teardrop" display in which the teardrop shapes represent probability distributions of wealth accumulation at the horizon, with different asset allocation strategies. Each teardrop is a conventional log-normal probability distribution which has been rotated 90 degrees and reflected about the wealth axis. Thus, the width of the teardrop shape at any wealth level is proportional to the probability of attaining exactly that wealth level.

In this embodiment, a mouse click on any point or cursor placement within the teardrop causes a text box to appear, not shown, showing the probability of achieving or exceeding the wealth accumulation to which the mouse cursor points. As previously stated, the probability distributions are calculated by assuming that logarithms of wealth at specified future times are normally distributed, with the target plan of net saving occurring when the investment return is equal to the required rate of return for the target scenario, and the fallback plan of net saving occurring at the 95th percentile of the probability distribution. Thus, the calculations of probability distributions of wealth accumulation incorporate the fact that the savings spending allocation at any time is dependent on the results of investment up to that time.

FIG. 6, the "advancing toward your goal" one exhibits, displays the same probability distributions represented by the teardrops except that they are displayed for a single optimally-allocated portfolio across time. The top line of the curve is the fifth percentile of the probability distribution of wealth accumulation at each future time, the second-to-top

line is the tenth percentile, the middle line is the 50th percentile, the next-to-lowest line is the 90th percentile, and the lowest line is the 99th percentile. In the computer system embodiment, as with the teardrops, a mouse click on any point within the cone causes a text box to appear showing the probability of achieving or exceeding the wealth accumulation at that wealth level and future time to which the mouse cursor points. Anomalies or "kinks" in the cone occur when sporadic large net cash inflows or outflows occur, such as during the college education of children or the planned future exercise of corporate stock options.

Persons skilled in the art may recognize other steps that can be added to the embodiment described above. Similarly, persons skilled in the art may recognize other alternatives to the steps or equations disclosed herein.

What is claimed is:

1. A computer implemented method for generating an optimal investment plan in probabilistic form and for displaying resulting probability distributions, the method utilizing a computer having a processor programmed to electrically process input data and output data, the processor being electrically connected to a keyboard and a visual display screen, the method comprising the steps of: inputting target and fallback scenarios and required probabilities, computing rate of return values responsive to the target and fallback scenarios, generating an efficient portfolio array, computing probabilities for the efficient portfolio array responsive to the rate of return values, comparing iteratively the array probabilities so that the target and fallback scenario probabilities are satisfied to select a qualified portfolio; and

Wallman Abstract**(57) ABSTRACT**

A computer-based system is disclosed for reducing risk, including market risk, for a given portfolio, by examining the expected risk, pricing it, and transferring some or all of it in exchange for consideration, which can be either cash, other property or part of the opportunity cost forgone in connection with or an assignment of part of the portfolio.